Suggested Installation, Specification and Performance Documentation To Be Submitted By Transmitter Site Operators

| Operational Characteristic to Be Documented | Suggested Test Documentation | Comments |
|---|---|---|
| Detailed Description of FCC-Approved Use(s) For Transmitting Facilities at This Site | Summary of Approved Site License, Application or Permit, Listing Approved Use(s) [Cellular, Commercial, Etc.] Equipment and Accessory Equipment | Copies of this information may be available from local, State or Federal sources, if Operator cannot or will not provide it. Details of substations or on-site equipment buildings, electrical requirements, etc.should also be included. |
| FCC-Allocated Operational Frequency Band For This Facility | Copy of approved FCC Frequency Allocation showing frequency band(s), side bands and ermissible Signal Deviation | State or Municipal Licensing or Permit-Granting Entities, or Regional FCC Offices Can Provide This Information |
| FCC or Regulating Authority Approval of Location of This Facility | Local Site Approval Agreement Detailing Exact Geographical Location of Facility, Including Municipal Plat Map, Easements, Use Conditions and Survey Coordinates. | Availability as above |
| Manufacturer Specifications for Transmitters To Be Installed at Site | Copies of Manufacturer Specification Sheets or Detailed Engineering Specifications for the model(s) of transmitters to be installed at site. | This documentation should include models to be installed and any possible substitutions. If replacements are made during the Permit Term, specifications and performance characteristics of alternatives must be submitted to the Monitoring Authority. |
| FCC-Allocated Maximum Number of Transmitters and/or Total Maximum Allowed Operational Output Power of The Proposed Facility | Listing from Site Operator, of minimum and maximum number of transmitters and configuration to be installed at Site | Operator's reported installation and operation plans can be compared with FCC Site License specifications. |
| Manufacturer Specifications and Designed Radiation Pattern for Antenna(s) and Transmitters To Be Installed At Site | Copies of Manufacturer Engineering Specifications | Accumulating a database of this information will provide baseline information about equipment performance/conditions scenarios and ultimately can expedite the Site Monitoring process |

Suggested Installation, Specification and Performance Documentation To Be Submitted By Transmitter Site Operators

| | | | |
|---|---|---|---|
| Post-Installation Transmitter Output Test Report | | Operator's Test Results from on-site Final Transmission Tests before facility goes on-line. Should include Spectrum Analysis and Intermodulation characteristics. | This data can be compared with The Suggested Comprehensive EMF Tests, proposed to be completed by the Monitoring Authority before construction begins, and can serve as documentation of Compliance with FCC and Regional mandates. |
| Post-Installation Antenna Radiation Pattern | | Antenna Characteristics results as above or combined with Transmitter Test Results | Data as above. Where electrical support facilities are installed, 60Hz E and H fields should be assessed +/- 5m around equipment building and at occupancy levels where such facility is within 10m of occupied buildings. |
| Comprehensive EMF Protocol Re-Test Report | | The following minimum EMF Tests must be performed by a 3rd Party and submitted to the Monitoring Authority: RF/MW Power Density, RF/MW Spectrum Analysis at 10M and 20M from Site and On All Floors of Inhabited Structures w/in 30M of antenna(s). | Upon completion of Operator's own Final Tests, it is recommended that Operator be required to contract a 3rd Party, at Operator's cost, to assess at minimum, RF/MW Power Density, Spectrum Analysis and Intermodulation characteristics at maximum output. |
| Reporting and Remediation of EMF Problems and Transmission Anomalies | | This data may be pertinent in litigation proceedings, so detailed and accurate documentation is a necessity. Emissions exceeding adopted population exposure standard should be re-tested by a competent 3rd. Party agreeable to both Operator and Authority. | Additionally, previously found anomalies should be re-tested using same GPS coordinates while new facility is tested at maximum. Intensification of former problems should be recorded with Authority and Operator, with remediation contingent to severity. |
| Compliance Enforcement, Warning Signage, Penalties and Remedies | | Local ordinances should contain clearly-defined penalties and remedies concerning breaches of compliance. The FCC process for such matters is very slow at present, and with passage of the Federal TelCom bill, will likely be even slower. | Where local EM fields of any frequency range are found to exceed any of the adopted standards, appropriate warning signs should be placed. 'Hot Spots' in presently open areas should be marked by Authority to caution human acess or future construction. |

## Biographical Profile: Carroll Adam Cobbs, M.S.


| | |
|---|---|
| **Address:** | 1011 Boren Ave. #184<br>Seattle, WA 9810<br>(206) 248-2336 |
| **Citizenship:** | US Citizen |
| **Marital Status:** | Divorced, 3 - Children |


### Education

**B.A. Degree, Neuroscience,** Antioch College, 1975

Field of Study: Psychobiology/Neuroscience (the physiological basis of behavior)

**M.S. Degree, Bioengineering,** University of Washington, 1992

Bioengineering is a graduate program involving joint studies in the Graduate School of Electrical Engineering and the University of Washington Medical School

Graduate Studies Concentration: Radiation Science and Medical Imaging
Bioelectromagnetics (under Dr. A.W. Guy and Dr. Ceon Ramon)
Mathematical Modeling

**Ph.D. Studies: Applied Physics/Bioengineering - Oregon Graduate Institute**
**(Accepted into Program - Delayed Matriculation)**

Areas of Concentration: EM Field Modeling, Intracellular Signaling
Physical Chemistry
Bioelectrodynamics

### Professional Certification

National Association of Radio and Telecommunications Engineers (NARTE)

*Certified Engineer - Class II* Certificate Number: E2-03393

Endorsements:

| | |
|---|---|
| RF Radiating - | Administrative/Regulatory<br>Interference Analysis/Suppression,<br>Expert Witness Testimony |
| Non-RF Radiating - | Computer Telecommunications |

**Exhibiit 4** **Balloting Information on IEEE C95.1-1991**
**Note from 2 person who voted NO**
**Votes of those voting**

# FOR ACTION

**Letter Ballot**
**of IEEE Standards Coordinating Committee, SCC28**
**as he submitted for**
**Approval of the Revision of ANSI Standard C95.1-1982,**
**Draft dated July 1990**

**American National Standard *Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz***

**Please return this ballot NO LATER THAN .. *April 15, 1991***

---

__________ **Approve (Affirmative) for IEEE Standard; comments on reverse or attached.**

__X__ **Disapprove (Negative) for reasons given on reverse or attached.**
(Note: In accordance with 3.7(2) of the IEEE Standards Manual, this vote must be accompanied by specific reasons in sufficient detail that the specific wording of the changes that will cause the negative voter to change the vote to "Approve" can readily be determined. In the absence of a reason for a negative vote after follow-up inquiry, the ballot shall be classified as "no response.")

**An abstention vote must be accompanied with the reason for abstaining; without a reason, an abstention will be classified as an unreturned ballot.**

__________ **Abstain for lack of time to review document.**

__________ **Abstain for lack of expertise.**

__________ **Abstain for** ____________________

---

**Voter Name: (Please type)** MAYS L SWICORD **Date:** 4/10/91

**Signature:** [signature] **Phone No.:** 301-443-7150

**Address:** FDA - HFZ 114
5600 FISHERS LANE
ROCKVILLE, MD 20857

---

**Return this original ballot (and comments) to:**

**R. C. Petersen**
**AT&T Bell Laboratories**
**Room 1F181C**
**600 Mountain Ave.**
**Murray Hill, NJ 07974**
**908-582-4442**

Four reasons for rejecting the standard are as follows.

1. I feel that the procedures agreed upon concerning membership and circulation of this document have not been fully carried out. A membership committee was appointed to consider a proper balance of representatives. To my knowledge this committee has not met. It is generally recognized that the current membership is not balanced in representing government, industry and the general public. Thus the ballot may not represent a proper balance. Secondly, we agreed at the fall meeting in 1989 to send out this document for agency review and comment. The second point may be considered minor but if the standard is to have credibility I feel it is necessary.

2. The inconsistancy of the exclusion clause with the basic standard.

3. Little attention has been paid to appropriate averaging time. The standard still uses 6 minutes for frequencies below 15 GHz. Six minutes was arbitrarily chosen and has no significance in terms of thermal loading to cells or any other biological response. There is some work by Wachtel which suggest some maximum values for consideration. There is other data ( work of Russ and others) which suggest that pulsed microwaves may give responses at lower average levels than CW. This problem should not be brushed aside.

4. The standard has been increased at the higher frequencies from the 1982 versions with very weak justification. There is the statement that this is a standard for the work place and does not include children. However, there are small adults. The factor of two is nothing to be concerned with. However, the appearance of arbitrarily increasing the level for practical engineering considerations with no health consideration will cause undue public concern of the committees actions. The justification should be strong and make sense or the values should be reduced to 1982 levels.

UNRESOLVED
NEGATIVE
VOTES

# FOR ACTION

Letter Ballot
of IEEE Standards Coordinating Committee, SCC28
to be submitted for
Approval of the Revision of ANSI Standard C95.1-1982,
Draft dated July 1990

American National Standard *Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz*

Please return this ballot: NO LATER THAN .. *April 15, 1991*

________ Approve (Affirmative) for IEEE Standard; comments on reverse or attached.

✓ Disapprove (Negative) for reasons given on reverse or attached.
(Note: In accordance with 5.7(3) of the IEEE Standards Manual, this vote must be accompanied by specific reasons in sufficient detail that the specific wording of the changes that will cause the negative voter to change the vote to "Approve" can readily be determined. In the absence of a reason for a negative vote after follow-up inquiry, the ballot shall be classified as "no response.")

An abstention vote must be accompanied with the reason for abstaining; without a reason, an abstention will be classified as an unreturned ballot.

________ Abstain for lack of time to review document.

________ Abstain for lack of expertise.

________ Abstain for ________________________________

Voter Name: (Please type) M.R. Altman, PhD Date: [illegible] Apr/91

Signature: ____________________ Phone No.: ____________

Address: ________________________________

Return this original ballot (and comments) to:

R. C. Petersen
AT&T Bell Laboratories
Room 1F101C
600 Mountain Ave.
Murray Hill, NJ 07974
908-[illegible]-6442
908-[illegible]-7874 (Fax)

See Comments of Dr. Mays Suicorp
of FDA.

THE INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, INC.

BALLOT SUMMARY

IEEE Project No. C95.1

SPONSOR: SCC-28 BALLOTING COMMITTEE: SCC-28 DATE 05-14-91

| NAME | COMPANY | Classification * | * | * | Vote Yes | No | Abstain | Not Ret. |
|---|---|---|---|---|---|---|---|---|
| Altman, M.R. | FDA/CDRH | | | G | | X | | |
| Baird, R.C. | NIST | | | AR | X | | | |
| Balzano, Q. | Motorola | | | IC | X | | | |
| Barron, N. | Dept. of Navy | | | A | X | | | |
| Brandinger, J. | David Sarnoff | | | AR | X | | | |
| Budinger, T. F. | Lawrence Berkeley Lab | | | AR | X | | | |
| Caine, S. | Dept. of Navy | | | A | | | | X |
| Case, D.R. | Dept. of the Air Force | | | A | X | | | |
| Cohen, J. | Jules Cohen Assoc. | | | C | X | | | |
| Dexter, D.P. | Dept. of the Army | | | A | X | | | |
| Delorge, J.O. | Dept. of the Navy | | | AR | X | | | |
| Durham, M.O. | U. of Tulsa | | | GI | X | | | |
| Elson, E.C. | Dept. of the Army | | | AR | X | | | |
| Erwin, D.N. | Dept. of the Air Force | | | AR | X | | | X |
| Fantozzi, G.U. | Florida P&L | | | IC | | | | |
| Guy, A.W. | U. of Washington | | | AR | X | | | |
| Heimer, G. | Consutant | | | C | X | | | |
| Hicks, C.W., Jr. | Dept. of the Army | | | A | X | | | |
| Hover, T. | Dept. of the Air Force | | | A | | | | X |
| Kerschner, H.F. | Dept. of the Navy | | | A | X | | | |
| Lin, J.C. | U. of Illinois | | | AR | X | | | |
| Maber, E.E. | Dept. of the Air Force | | | AR | X | | | |
| McDermott, T.J. | NY Power Auth. | | | UU | X | | | |
| Mitchell, J.C. | Dept. of the Air Force | | | AR | X | | | |
| Osepchuk, J.M. | Raytheon Research | | | IC | X | | | |
| Petersen, R.C. | AT&T Bell Labs | | | IC | X | | | |
| Roberts, B. | Dept. of the Army | | | A | X | | | |
| Ross, R. | Dept. of the Navy | | | A | X | | | |
| Schwann, H.P. | U. of PA | | | AR | X | | | |
| Spaulding, N.E. | Houston P&L | | | UU | X | | | |
| Steele, J.A. | Dept. of the Army | | | A | | | | X |

Notes:
Not Returned = No ballot received after second request. * See attached sheet for [illegible]

THE INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, INC.

**BALLOT SUMMARY**

IEEE Project No.________

SPONSOR: SCC-28 BALLOTING COMMITTEE: SCC-28 DATE: 05-14-93

| NAME | COMPANY | Classification | | | Vote Yes | No | Abstain | Not Ret. |
|---|---|---|---|---|---|---|---|---|
| Storm, F.X. | U. of Wisconsin | | | AR | X | | | |
| Swicord, M. | FDA/CDRH | | | BR | | X | | |
| Yacovissi | Dept. of the Navy | | | A | X | | | |
| Zipse, D. | FMC Corp. | | | IC | X | | | |
| Bassen, H. | FDA/CDRH | | | BR | X | | | |

A = ADMINISTRATIVE
AR = APPLIED RESEARCH
BR = BASIC RESEARCH
C = CONSULTANT
GI = GENERAL INTEREST
IC = INDUSTRIAL / COMMERCIAL
R = REGULATORY
U/U = USER/UTILITY

Notes:

Exhibit #5: IEEE C95.1-1991 Final List Paper9

V.S. Belokrinitskiy, "Destructive and Reparative Processes in Hippcampus with Long Term Exposure to Nonionizing Radiation," in U.S.S.R. Report, "Effects of Nonionizing Electromagnetic Radiation, No. 7, JPRS 81865, pp. 15-20

UDC: 616.831.314-001.28-003.9

# DESTRUCTIVE AND REPARATIVE PROCESSES IN HIPPOCAMPUS WITH LONG-TERM EXPOSURE TO NONIONIZING MICROWAVE RADIATION

Moscow BYULLETEN' EKSPERIMENTAL'NOY BIOLOGII I MEDITSINY in Russian Vol 93, No 3, Mar 82 (manuscript received 4 Nov 81) pp 89-92

[Article by V. S. Belokrinitskiy, Kiev Scientific Research Institute of General and Communal Hygiene imeni A. N. Marzeyev, Ukrainian Ministry of Health, submitted by N. A. Krayevskiy, academician of the USSR Academy of Medical Sciences]

[Text] Key words: nonionizing microwave radiation; hippocampus; destructive and reparative processes.

The data in the literature concerning functional disturbances in the central nervous system of individuals exposed to nonionizing radiation [4-7], as well as the results of our previous studies [1-3], prompted us to conduct special studies to determine the pathogenesis of these disturbances and their clinical manifestations.

We describe here a study of ultrastructural changes in the brain with long-term exposure to nonionizing microwave radiation (NMR) of low intensity. We chose the hippocampus, which is one of the main elements of the limbic system that is related to many functions of the body, including memory and mental status, as the object of our studies.

## Methods

Experiments were conducted on male rats exposed to NMR (wavelength 12.6 cm) for 40 min 3 times a day, at intervals of 3-4 h, at the same time of day for 2 months. One group of animals was exposed to NMR with intensity of 1000 $\mu W/cm^2$, another 50 $\mu W/cm^2$, the third 25 $\mu W/cm^2$ and the fourth 10 $\mu W/cm^2$. The animals were irradiated using a Luch-58 unit, with monitoring of dosimetry in an anechoic chamber, in which the rats were placed in special cages. A group of intact rats served as a control. There were 100 animals in each group, and at different times various parameters were determined using physiological, biochemical and histochemical methods.

For electron microscopy, the brain was perfused, adhering thereafter to all stages and rules for examining the ultrastructure of nerve tissue. We submitted three layers of the hippocampus (horn of Ammon) to electron microscopic analysis: alveus, layer of polymorphic cells and layer of pyramidal cells.

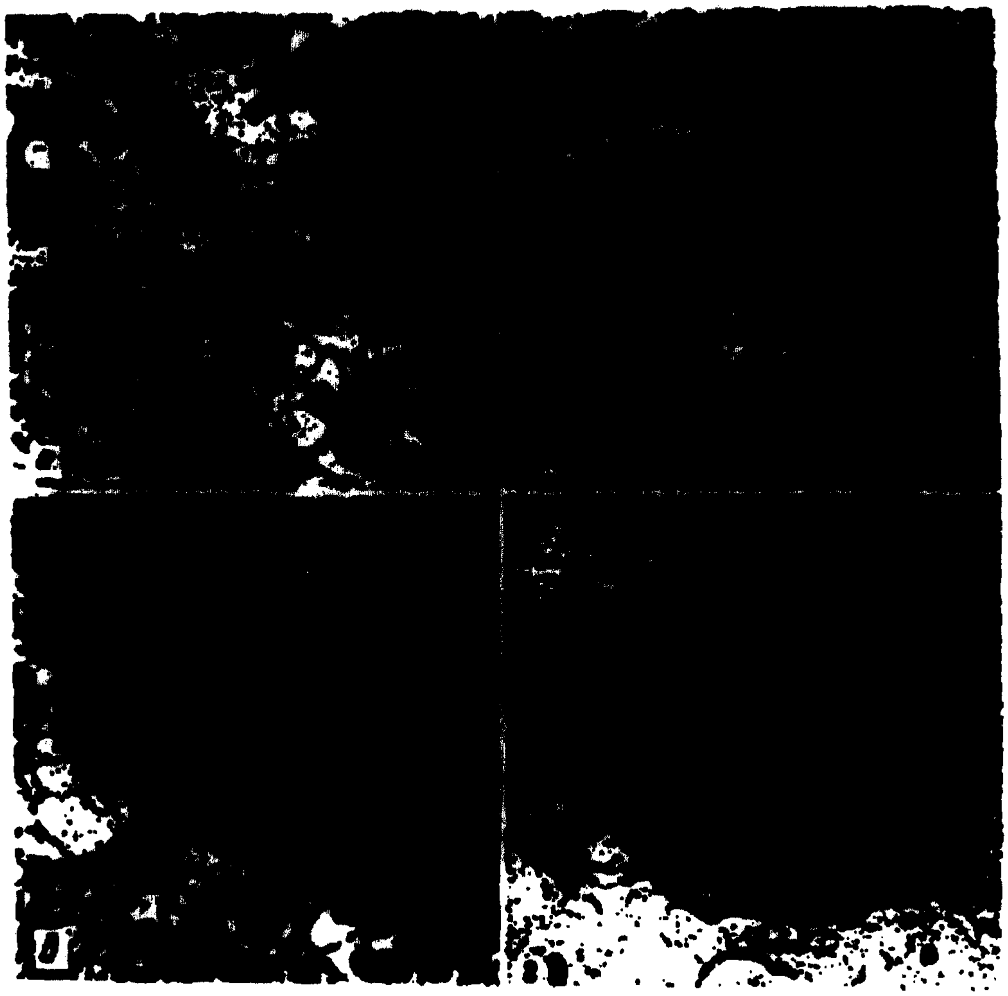

Figure 1. Ultrastructural changes in rat hippocampus with exposure to EMR of 1000 $\mu W/cm^2$ for 2 months

а) alveus layer: swelling of mitochondria in longitudinal section of unmyelinated nerve fiber, increased electron density; magnification 10,800×

б) layer of polymorphic cells: considerable swelling and elongation of mitochondria in longitudinal section of myelinated nerve fiber, local demyelinization and thinning of neurofibrils; magnification 16,000×

в) vacuolization of cytoplasm and structural change in chromatin of polymorphic layer cell; magnification 15,800×

г) condition of microglial cell in polymorphic layer; magnification 14,600×

## Results

In animals exposed to EMR with intensity of 1000 $\mu W/cm^2$, most of the nerve fibers in the alveus, which consisted mainly of myelinated and unmyelinated nerve fibers that are neural conductors entering and exiting from the hippocampus, had altered structural elements, as compared to the control. Both the sheathes of nerve fibers and neurofibrils of axis cylinders, including their organoids, were altered. The most distinct demonstration of changes was in the mitochondria (Figure 1a). The mitochondria presented considerably enlarged dimensions, altered shapes (convoluted and very long) and electron density: the mitochondria were dark, and the structure of their membranes, cristae and septa was not demonstrable. There was an increased quantity of mitochondria. There was localized demyelinization in the form of clearing of the myelin layer. Ranvier's crosses and Schmidt-Lantermann incisures were not demonstrable. There was irregular thinning of neurofibrils and impairment of their integrity. We encountered vacuolization in virtually all nerve fibers. The vacuoles differed in shape and size. There were many of them. Occasionally droplets were found deep in the fibers, which resembled lipofuscin or altered lysosomes.

We found considerably fewer nerve fibers in the polymorphic cell layer than the alveus. However, here too there was distinct demonstration of fibers with altered structural elements. The nature of the changes was analogous: vacuolization, regressive transformation of myelin, irregular thinning and fragmentation of neurofibrils, swelling and increase in electron density of mitochondria, and others (Figure 1b). In this same layer, there were nerve and glial cells whose structural elements were also considerably altered. More marked changes were found in neurons (Figure 1c). They were characterized by presence of vacuoles differing in shape and size, virtually complete disappearance of organelles from some parts of the cytoplasm with presence of pathological mitochondria in other parts, considerable diffusion and disappearance of chromatin granules in the center of the nucleus and concentration thereof near the membrane (clearing of the nucleus), ectopia of nucleoli. Cytoplasmic and nuclear membranes were not distinct. There was less change in structural elements of neuroglial cells than neurons. They had a more compact nucleus and somewhat cleared cytoplasm (Figure 1d).

The ultrastructure of nerve elements in the pyramidal cell layer also underwent changes. The nature of the changes was analogous to that demonstrated in the preceding layers of this structure. However, they were less marked and frequent than in the alveus and polymorphic cell layer. Here, we encountered more often neurons with virtually normal nucleus, although the cytoplasm of these neurons was vacuolized and there were pathologically altered mitochondria, with absence of other organelles, as indicated by the cleared cytoplasmic sections.

In animals exposed to EMR with intensity of 50 $\mu W/cm^2$, vacuolization, localized clearing and disappearance of the myelin sheath, irregular thinning and fragmentation to the extent of complete dissolution of neurofibrils were demonstrable in the alveus, in both myelinated and unmyelinated nerve fibers. Against this background, the pathologically altered mitochondria were more distinct. They were enlarged and presented increased electron density. Their cristae, septa and membranes were not demonstrable. Other organelles were not demonstrable.

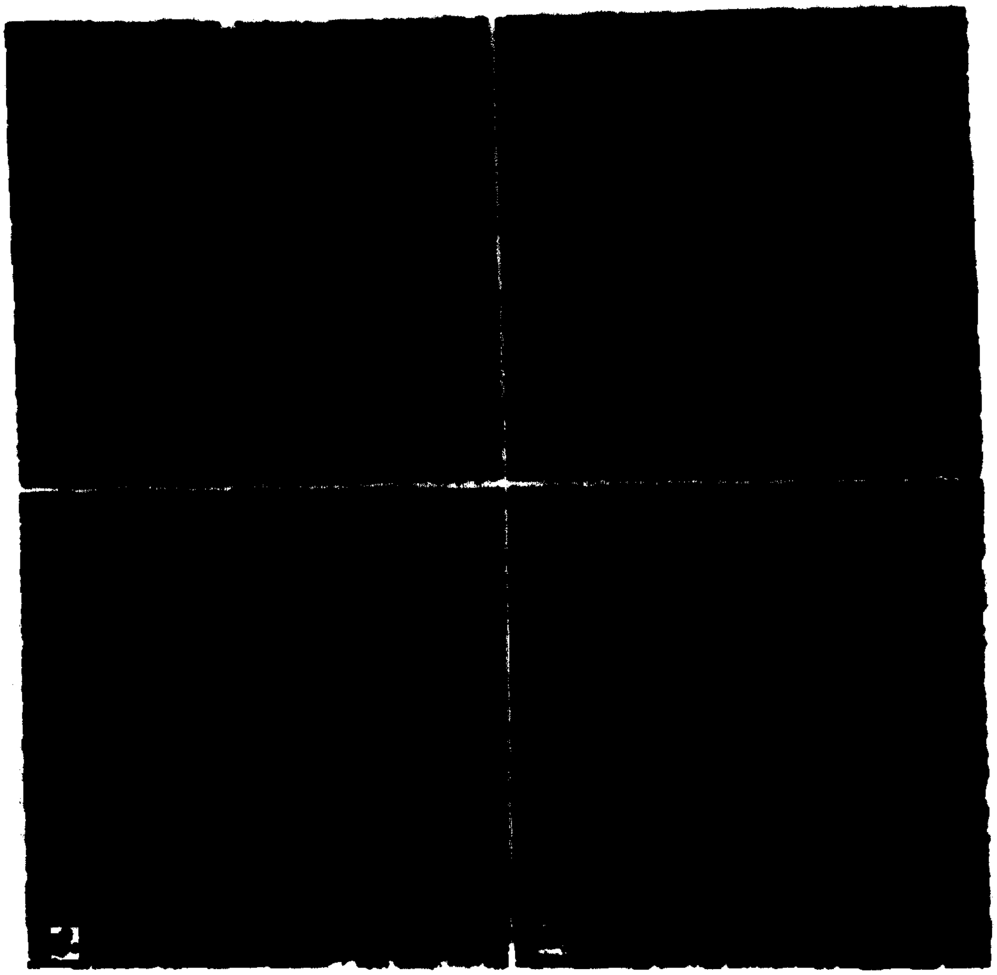

Figure 2. Ultrastructural changes in rat hippocampus with exposure to EMR of 25 µW/cm² (а, б) and 10 µW/cm² (в, г) for 2 months

а) segment of body of pyramidal layer cell: accumulation of altered mitochondria in one part of the cytoplasm and none in another; magnification 10,000×
б) virtually normal ultrastructure of polymorphous layer cells, magnif. 4600×
в) cross section of nerve fiber (alveus layer) with insignificant mitochondrial changes, magnification 9500×
г) unmyelinated nerve fiber in polymorphic layer, in which two mitochondria with different degrees of destruction of cristae and septa are distinctly visible; magnification 16,000×

In the layer of polymorphic cells, the demonstrated ultrastructural changes in the cytoplasm and nuclei were analogous to those observed in the polymorphic layer of the hippocampus of animals in the preceding series of experiments. However, there was less marked impairment of neuroglial ultrastructure.

In the layer of pyramidal cells, the ultrastructural changes were of the same type as in the analogous hippocampal layer of animals in the preceding series of experiments. However, most of the karyoplasm neurons had a virtually normal appearance, with a normal nucleolus. Such nuclei were seen even in neurons whose cytoplasm was altered.

In animals exposed to EMR with intensity of 25 and 10 $\mu W/cm^2$, we demonstrated less significant changes in ultrastructure than in animals exposed to EMR of higher intensity, and virtually normal cells were encountered (Figure 2). In animals exposed to EMR of 25 $\mu W/cm^2$, preservation of intact neurofibrils was seen more often than in other groups of animals. With emission intensity of 10 $\mu W/cm^2$, along with dark (increased electron density) mitochondria, we saw lighter ones whose structure was partially visualized, and they had an almost normal appearance. There we demonstrated more distinctly the endoplasmic reticulum (although it was altered), which was not observed in the animals used in the preceding series of experiments, as well as neuroglial cells—macrophages and microphages. Their cytoplasm contained many diverse inclusions due to their electron density.

In these groups of animals we occasionally demonstrated structures resembling synapses. However, since many elements inherent in synapses were wanting, we decided not to consider them as synapses.

Thus, it was determined that long-term exposure to EMR with intensity of 1000 to 10 $\mu W/cm^2$ (3 times a day, 40 min at a time, for 2 months) elicits changes in ultrastructure of the hippocampus. The nature of the demonstrated changes is indicative of two opposite processes—destruction and repair—which sometimes take place in the same cell. The intensity of these processes depends on the intensity of EMR. The demonstrated ultrastructural changes can, most probably, affect their function and constitute one of the elements in pathogenesis of early disturbances in people who have been exposed to this environmental factor.

## BIBLIOGRAPHY

1. Belokrinitskiy, V. S., in "Biofizicheskiye zakonomernosti deystviya fizicheskikh agentov na organizm" [Biophysical Patterns of Effects of Physical Agents on the Organism], Kiev, 1966, pp 7-9.

Idem, in "Ukrainskaya nauchn.-tekhn. konf., posvyashch. dnyu radio. 19-ya. Materialy" [Ukrainian Scientific and Technical Conference Dedicated to the Day of Radio, 19th, Proceedings], Kiev, 1979, pp 16-17.

Idem, ZH. VYSSH. NERV. DEYAT., No 3, 1971, pp 523-534.

Idem, in "Nevrologiya i psikhiatriya" [Neurology and Psychiatry], Kiev, Vyp 3, 1973, pp 25-28.

2. Belokrinitskiy, V. S. and Nikitina, N. G., VRACH. DELO, No 3, 1976, pp 127-131.

3. Belokrinitskiy, V. S. and Tarasyuk, N. Ye., Ibid, No 3, 1979, pp 102-105.

4. Drogichina, E. A., in "Gigiyena truda i biologicheskoye deystviye elektromagnitnykh voln radiochastot" [Industrial Hygiene and Biological Effects of Radio-Frequency Electromagnetic Waves], Moscow, 1978, pp 42-44.

5. Tyagin, N. V., "Clinical Aspects of Exposure to Superhigh-Frequency Waves," Leningrad, 1971.

6. Pazderova, J., PRAC. LEK., Vol 23, 1971, pp 376-379.

7. Styblova, V., Holanova, V., Brymdova, V. et al., Ibid, pp 353-358.



10,657
CSO: 1840/323

**Exhibit 6**

1. Policy statement from New Zealand Ministry of Education on no longer signing leases for telecommunications facilities

2. California Public Utilities Commission recommending personal wireless services not be near schools

3. Newpaper article documenting how personal wireless services transmitters are being placed at low heights Seattle Times July 19, 1996, pg. D1

4. Notice in the Los Angeles Times on LA Cellular apologizing for non-compliance, April 16, 1995, LA Times pg A14

5. Excerpts from ANSI Z136.1-1993 pg. 31, 34 and -1996 pg. 28. These show that the allowed limits are expected to likely be uncomfortable to view and feel upon the skin, and gives the power density for partial body exposures.

considerations may apply for multiple exposures (see 8.2.2.1).

**8.2.2 Exposure Duration.** For a single-pulse laser, the exposure duration is equal to the pulse duration, $t$, defined at its half-power points. For a cw visible (400 to 700 nm) laser, the exposure duration is the maximum time of anticipated direct exposure, $T_{max}$. If purposeful staring into the beam is not intended or anticipated, then the aversion response time, 0.25 s, may be used.

For non-visible wavelengths (less than 400 nm or greater than 700 nm), the cw exposure duration is the maximum time of anticipated direct exposure, $T_{max}$. For the hazard evaluation of retinal exposures in the near-infrared (700 to 1400 nm), a maximum exposure duration of 10 s provides an adequate hazard criterion for either unintended or purposeful staring conditions. In this case, eye movements will provide a natural exposure limitation eliminating the need for exposure durations greater than 10 s, except for unusual conditions. In special applications, such as medical instrumentation, even longer exposure durations may apply.

For repetitively pulsed lasers, the total exposure duration, $T$, of the train of pulses must be determined. This duration is determined in the same manner as is used for cw laser exposures. The method for determining the MPEs for repetitively pulsed laser exposures is given in 8.2.2.1 and 8.2.2.2. For pulse widths less than 1 ns, see Note in Section 8.

**8.2.2.1 Repeated Exposures, Ultraviolet (315 to 400 nm) — Special Considerations.** For repeated exposures, the exposure dose is additive over a 24-hour period, regardless of the repetition rate. The MPE for any 24-hour period should be reduced by a factor of 2.5 times relative to the single-pulse MPE if exposures on succeeding days are expected.

**8.2.2.2 Repeated Exposures, Visible (400 to 700 nm) and Infrared (>700 nm).** Both scanned cw lasers and repetitively pulsed lasers can produce repetitively pulsed exposure conditions. The MPE per pulse for repetitively pulsed intrabeam viewing is $n^{-1/4}$ times the MPE for a single pulse exposure where $n$ is the number of pulses found from the product of the prf and the exposure duration ($T$) as defined in 8.2.2. (See Figure 12 for a graphical representation of $n^{-1/4}$.) This MPE applies to all wavelengths greater than 700 nm (thermal injury). For wavelengths less than 700 nm, the MPE as calculated on the basis of $n^{-1/4}$ also must not exceed the MPE calculated for $nt$ seconds when $nt$ is greater than 10 s.

For pulse repetition frequencies greater than 15 kHz, the average irradiance or radiant exposure (radiance or integrated radiance) of the pulse train shall not exceed the MPE (as given in 8.2) for a single pulse equal in duration to the pulse train duration, $T$.

For wavelengths between 400 and 700 nm, the aversion response time, 0.25 s, may be used unless purposeful staring into the beam is intended or anticipated. For wavelengths greater than 700 nm, 10 s may be used as the exposure duration unless purposeful staring into the beam is intended or anticipated.

**8.3 MPE for Extended-Source Viewing.** MPE values for ocular exposure to extended sources for single pulses or exposures are given in Table 6. All values are specified at the cornea. (See 8.5 for special qualifications and use; see also Figs. 5, 6, and 7.) For multiple pulse lasers or exposures, the MPE is determined using the exposure time of the pulse train duration, $T$.

**8.4 MPE for Skin Exposure to a Laser Beam.** MPE values for skin exposure to a laser beam are given in Table 7. These levels are for worst-case conditions and are based on the best available information.

**8.4.1 MPE for Skin, Repeated Exposures** For repetitive-pulsed lasers the MPEs for skin exposure are applied as follows: Exposure of the skin shall not exceed the MPE based upon a single-pulse exposure, and the average irradiance of the pulse train shall not exceed the MPE applicable for the total pulse train, duration $T$. (See 8.5 for special qualifications and uses.)

**8.4.2 Wavelengths Greater than 1.4 μm.** For beam cross-sectional areas between 100 cm$^2$ and 1000 cm$^2$, the MPE for exposure durations exceeding 10 s is 10,000/$A_s$ mW/cm$^2$, where $A_s$ is the area of the exposed skin in cm$^2$. For exposed skin areas exceeding 1000 cm$^2$, the MPE is 10 mW/cm$^2$.

**8.5 Special Qualifications — Infrared.** Available data is not sufficient to define wavelength corrections relative to 1.06 μm over the entire infrared range (1.4 μm to 1 mm). At 1.54 μm,



For Partial Body

IEEE 1991 allows up to 40 mW/cm

at higher & frequencies 

(5) Gases of different categories (toxics, corrosives, flammable, oxidizers, inerts, high pressure, and cryogenics) not stored separately in accordance with OSHA and Compressed Gas Association requirements.

**7.8 Laser Dyes.** Laser dyes are complex fluorescent organic compounds which, when in solution with certain solvents, form a lasing medium for dye lasers. Certain dyes are highly toxic or carcinogenic. Since these dyes frequently need to be changed, special care must be taken when handling, preparing solutions, and operating dye lasers. A MSDS for dye compounds shall be available to all appropriate workers.

The use of dimethylsulfoxide (DMSO) as a solvent for cyanine dyes in dye lasers should be discontinued if possible. DMSO aids in the transport of dyes into the skin. If another solvent cannot be found, low permeability gloves should be worn by personnel any time a situation arises where contact with the solvent may occur.

Dye lasers containing at least 100 milliliters of flammable liquids shall be in conformance with the provisions of the NFPA (NFPA 30, 45, and 99), and the NEC (Article 500 - Hazardous (classified) Locations).

**7.9 Mechanical Hazards Associated with Robotics.** In many industrial applications lasers are employed in conjunction with robots. In these situations, the mechanical safety of the robot installation must be carefully considered.

A number of accidents have occurred where a worker has been pinned between a robot and a confining object ("pinch effect"). The LSO should ensure that approaches to prevent these types of accidents are in place. These approaches may include the use of surface interlock mats, interlocked light curtains, or non-rigid walls and barriers. The installation should conform to recommendations contained in the document ANSI/RIA R15.06-1986 *Standard for Industrial Robots and Robot Systems-Safety Requirements* or latest revision thereof.

**7.10 Noise.** Noise levels from certain lasers, such as excimer lasers, may be of such intensity that noise control may be necessary. Consult the US Department of Labor, Occupational Safety and Health Administration Regulations and the ACGIH TLVs.

**7.11 Waste Disposal.** Proper waste disposal of contaminated laser-related material, such as flue and smoke filters, organic dyes, and solvent solutions shall be handled in conformance with appropriate local, state, and federal guidelines.

**7.12 Confining Space.** In many laser system installations, space is at a minimum. Confining space can be a problem when working around high voltage equipment (see the National Electric Code, Section 110-16). There must be sufficient room for personnel to turn around and maneuver freely. This issue is compounded when more than one type of laser is being operated at the same time. Whenever lasers or laser systems are used in confining space, local exhaust, mechanical ventilation and respiratory protection shall be used if LGAC's are present.

**7.13 Ergonomics.** Ergonomic problems can exist in certain laser operations that can cause unique arm, hand, and wrist deviations. If such repetitive deviations occur for long periods of time medical problems such as carpal tunnel syndrome can arise. The LSO should be aware of this problem and become familiar with appropriate user control measures.

## 8. Criteria for Exposures of Eye and Skin

Maximum permissible exposure (MPE) values are below known hazardous levels. Exposure to levels at the MPE values given may be uncomfortable to view or feel upon the skin. Thus, it is good practice to maintain exposure levels as far below the MPE values as is practicable.

A limiting aperture shall be used for measurements or calculations with all MPE values. This limiting aperture is required, because the MPE has been expressed (normalized) relative to the limiting aperture area. The limiting aperture is the maximum circular area over which irradiance and radiant exposure can be averaged (see Sections 3 and 9 for selection and application of the appropriate aperture).

The irradiance values for the MPEs in Table 5 can be obtained by dividing the radiant exposure by the exposure duration, t, in seconds. Values for the radiant exposure can be obtained by multiplying the irradiance by the exposure duration, t, in seconds (Appendix G provides reference material on this subject).

This applies to the exposure at higher frequencies of IEEE1991
Does the commission want the general public to feel uncomfortable?

applicable for a 0.07 s exposure. For exposure durations longer than 0.7 s, the MPE should be reduced by a factor of 5.4 for wavelengths between 0.4 and 0.6 µm, and by a factor, $10^{7.4(0.7-\lambda)}$ for wavelengths between 0.6 and 0.7 µm.

When the eye is immobilized or otherwise constrained so that the image on the retina is stabilized and the exposure duration is longer than 3.2 s, both the intrabeam viewing and the extended source exposure are limited to 20 $C_B$ J/(cm$^2$ sr) averaged over 1.5 mrad.

**8.4 MPE for Skin Exposure to a Laser Beam.** MPE values for skin exposure to a laser beam are given in Table 7. These levels are for worst- case conditions and are based on the best available information.

**8.4.1 MPE for Skin, Repeated Exposures.** For repetitively pulsed lasers the MPEs for skin exposure are applied as follows: Exposure of the skin shall not exceed the MPE based upon a single-pulse exposure, and the average irradiance of the pulse train shall not exceed the MPE applicable for the total pulse train, duration T.

**8.4.2 Wavelengths Greater than 1.4 µm.** For beam cross-sectional areas between 100 cm$^2$ and 1000 cm$^2$, the MPE for exposure durations exceeding 10 s is 10,000/$A_s$ mW/cm$^2$, where $A_s$ is the area of the exposed skin in cm$^2$. For exposed skin areas exceeding 1000 cm$^2$, the MPE is 10 mW/cm$^2$.

## 9. Measurements

**9.1 General.** The laser classification scheme described in Section 3 is designed to minimize the need for laser measurements and calculations by the user. Generally, such measurements are required only when manufacturer's information is not available, when the laser or laser system has not been classified by the manufacturer in accordance with the Federal Laser Products Performance Standard, or when alterations to a system may have changed its classification.

The cumulative error due to all sources of inaccuracy (both systematic and statistical), including human factors, operating conditions, and instrumental errors, shall not exceed ±20%, or, if this is not possible, the best that the state of the art reasonably will permit. It is important to recognize that measurements improperly performed may be worse than no measurements, since they may imply a safe condition that does not actually exist. Experience has shown that measurement errors well in excess of ±20% are commonly made and often are unidentified.

If measurements are performed, the accuracy of the instrumentation should be traceable to national standards, either directly to the National Institute of Science and Technology (NIST) or to other transfer standards traceable to NIST. The NIST conducts programs for assistance in meeting these requirements. (See references in H4.)

Measurements should be attempted only by personnel trained or experienced in laser technology and radiometry. Routine survey measurements of lasers or laser systems are neither required nor advisable when the laser classifications are known and the appropriate control measures implemented.

If a laser or laser system is used outdoors over long ranges, where the uncertainties of propagation influence exposures, or where the beam divergence is uncertain, measurements may be useful.

Measurements shall be made with the laser adjusted for maximum output for the intended use.

**9.2 Intrabeam and Extended-Source Measurements.** If measurements or calculations are required, distinction shall first be made between intrabeam viewing and extended-source viewing in the 0.4 to 1.4 µm wavelength region. For the purpose of this standard, an extended source subtends an angle at the observer's eye greater than the angular subtense, $\alpha_{min}$, (shown in Fig. 3), across the smallest angular dimension of the source as viewed by the observer.

**9.2.1 Radiance.** The maximum radiance of an extended source, such as the *scattering* of a laser beam from a diffuse surface, shall be determined by measurement. The measurement may average over the appropriate conical field of view defined by the angular subtense, $\alpha_{min}$, or over a 1 mm diameter circular area, whichever gives the larger value of radiance. In the case of nonuniform extended-source profiles, such as those resulting from inhomogeneous beams or "hot spots," the measurement shall be taken from the regions of greatest radiance.

**9.2.2 Irradiance or Radiant Exposure.**

**9.2.2.1 Limiting Aperture.** The measurement of irradiance or radiant exposure shall be made with instruments that average over circular areas defined by the effective limiting aperture diameters given in

MINISTRY OF EDUCATION
PROPERTY MANAGEMENT

21 March 1996

**Cell phone Transmitters on School Sites - Policy Statement**

From 1992 it has been possible for Boards of Trustees to enter into agreements with Telecom for the establishment of cell phone transmitters on schools sites. The decision to install a transmitter on a school site was left entirely at the boards discretion.

In December 1994 concerns were expressed by some members of the general public and some boards of trustees and parents about the safety of cell phone transmitters on school sites.

The National Radiation Laboratory expressed the view that:

- Cell phone transmitters operate well within the New Zealand Standard 6609 for UHF and microwave electromagnetic radiation levels.
- With few exceptions, nearby residents of cell phone base stations are exposed to levels less than 1% of the general public exposure limit set out in the New Zealand Standard 6609.
- There is no conclusive evidence that short or long term exposures at these low levels are harmful.

However of paramount importance to the Ministry is the provision of an environment where boards of trustees, parents, teachers and pupils and other occupants of the school site can feel comfortable. For this reason the Ministry has decided cellphone transmitters will not be sited on Crown owned school sites in the future.

J Simpson

John Simpson
National Property Manager

*National Office,*
*45-47 Pipitea Street, Thorndon, Private Box 1666, Wellington, New Zealand*
*TELEPHONE: (04) 473-5544, FACSIMILE: (04) 471-4414*

California Public Utilities Commission

# NEWS RELEASE

505 Van Ness Avenue San Francisco, CA 94102-3298

CONTACT: Dianne Dienstein
415-703-2423

November 8, 1995 CPUC -107
(I.91-01-012)

## CPUC REMAINS WATCHFUL REGARDING RF/EMF FROM CELLULAR TOWERS

The California Public Utilities Commission (CPUC) today ordered cellular utilities to identify and address public concerns about potential health problems from electromagnetic field (EMF) and radio-frequency (RF) exposure in siting and building new cellular towers. It urged cellular companies to site facilities away from schools and hospitals, and to restrict access to sites with warning signs and barriers.

The Commission's jurisdiction is limited to cellular towers and related facilities - it does not regulate cellular phones. The federal Food and Drug Administration regulates RF emissions from consumer/industrial devices and is looking into RF emissions from hand-held cellular phones.

Due to public concern and scientific uncertainty regarding the potential health effects of EMF exposure, the Commission examined what steps should be taken to mitigate the health effects, if any, of RF and EMFs from the 1,000 cellular facilities in California. It found no scientific link between EMFs and adverse health effects on humans from cellular facilities.

A steering committee composed of one representative each from the CPUC Commission Advisory and Compliance Division, CPUC Division of Ratepayer Advocates, state Department of Health Services, Cellular Carriers Association of California, and Citizens Concerned About Telecommunications EMF held an EMF informational workshop on July 21, 1993 for interested individuals and organizations. The workshop was videotaped for those who could not attend.

- more -

The workshop report, included with the Commission decision today, identified levels of cellular utilities' EMF and RF radiation impacts, issues for further consideration and interim safety measures.

The Commission will not adopt a specific numeric standard for RF/EMF exposure associated with cellular facilities because it is premature to do so given no scientific evidence of a definite link between cellular facility EMF exposure and adverse health effects.

However, as more scientific research is completed, Commission action may become necessary. The CPUC Commission Advisory and Compliance Division will keep track of cellular EMF/RF research findings and information, advise the Commission if action is needed to address them, and convene periodic workshops to share that information with all interested parties.

###

but there is strong suggestive evidence.